DOCUMENT RESUME

ED 319 359 IR 014 276

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TITLE Research on Wordprocessing and Writing Instruction.
PUB DATE Mar 89
NOTE 6p.; Paper presented at the American Educational Research Association (San Francisco, CA, March 30-April 2, 1989).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; Computer Software; Effect Size; *Instructional Effectiveness; Intermode Differences; Meta Analysis; *Student Attitudes; *Thinking Skills; *Word Processing; Writing Instruction; *Writing Skills
IDENTIFIERS Higher Order Learning

ABSTRACT

In response to critics' charges that use of the word processor may have a detrimental effect on writing, this study identified and analyzed 20 published studies that used experimental and control groups to compare conventional writing instruction (using handwriting) with instruction using the word processor. Five types of outcomes were analyzed: (1) number of revisions; (2) composition length; (3) students' attitudes toward writing; (4) basic writing skills (e.g., spelling, punctuation, and grammar); and (5) overall quality of written documents. Because a true meta-analysis was not possible using the available studies, calculation of effect sizes was supplemented with a narrative summary procedure. In spite of the various pitfalls that plagued the studies, word processing still proved to be a beneficial addition to writing instruction. Word processing appeared to increase students' enjoyment of writing and stimulate them to compose longer documents. Unexpectedly, it was found that word processing also tends to improve performance of basic writing skills. The securest finding, which came from 13 of the 15 studies that examined overall quality of writing, was that students instructed with word processing produced papers of better quality than students who produced handwritten papers. On the basis of these findings, it can tentatively be concluded that the word processor operates as an unsophisticated instructional tool (i.e., it instructs as it is being used) although it does not explicitly stimulate metacognitive activity. (8 references) (GL)

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# Research on wordprocessing and writing instruction

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*Paper presented at the annual meeting of the American Educational Research Association*
*San Francisco, March, 1989*

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Instructional software can be distinguished by the different ways in which they affect human information processing. One can imagine these software arranged on a continuum according to whether they supplant or activate the students' capacity to teach themselves. Tutorials and instructional tools mark the continuum's extremes (Kozma & Bangert-Drowns, 1987). Tutorials are software that provide explicit guidance to learners, supplanting metacognitive and intellectual skills to teach specific declarative knowledge. Instructional tools, on the other hand, empower or extend cognitive processes by assuming some portion of the tasks that are usually time-consuming, repetitive, tedious, and/or "lower-level". Instructional tools might be as simple as four-function calculators or they can be as complex as the computer itself. In any case, the instructional tool takes input from a learner and facilitates transformations on the input, transformations that in some way extend or empower human mental capacity.

Tutorials have implicit or explicit objectives, and give specific guidance and practice to achieve those objectives. Obviously, instructional tools do not instruct in the same sense. To be educationally significant, instructional tools must do one or more of the following (Salomon, 1988):

1. Enable students to mindfully attend to more complex mental tasks by performing simpler, time-consuming mental tasks;
2. Strategically present choices which require the mobilization or acquisition of specific knowledge for selection;
3. Strategically present questions, comments, or signals to stimulate the use of metacognitive skill; or
4. Provide implicit or explicit models of information representation, processes, or strategies.

Just as a child learns new skills through social interaction before they are internalized, so learners can acquire new skills in interactive partnership with their instructional tools. In short, tools can transform human cognition because they can allow learners to practice, and thus enhance, skills that otherwise would not have been practiced as frequently, or because they permit the internalization of information representations, processes, or strategies exhibited or stimulated by the tool.

Can the word processor be an instructional tool? That is, do students learn new skills from their partnership with this specialized writing device? The typical wordprocessor is not a particularly intelligent tool. It usually does not analyze or markedly alter data entry; it does not explicitly stimulate or model metacognitive processes. Its greatest and most obvious function is what Perkins (1985) calls first-order fingertip effects; that is, it puts considerable power at our fingertips, allowing the manipulation of text for the production of high-quality printed documents. But does it produce second-order fingertip effects, increased capacity for higher-order thinking?

The typical wordprocessor allows users to make changes to text that would have been more cumbersome on paper. These changes range from simple editing (e.g., corrections in punctuation, spelling, grammar), to the addition and deletion of single words or simple phrases, to more substantial revision (e.g., rearranging sentences in paragraphs, reordering large blocks of text, rewriting text for greater coherence). The effects of these functions may be twofold. First, they offer a particular representation of the nature of text, text as a fluid and easily transformed communication and therefore as closely connected to thinking and speaking. Secondly, they allow

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the user to attend to higher-order decisions (for example, revision for clarity of communication) by removing the mechanical difficulties involved in changing text. Users of word processors might therefore compose longer documents and engage in more revision of their documents than comparable users of simpler technologies. Given these extra efforts in the context of feedback from teachers and peers in writing instruction, we might expect an improvement in the quality of writing (though this improvement will be limited by the degree to which students had good writing skills to begin with, the degree to which these skills are addressed in feedback from teachers and peers, and the degree to which these skills were inhibited by the mechanical aspects of writing). Having thus practiced such skills while on the wordprocessor, students might continue such practices even when writing by hand. We might further predict that the ease of revision and close connection to personal communication, combined with the improved appearance of writing products and the excitement of using a high technology, would collectively contribute to the improvement of students' attitudes toward writing.

Though the word processor has been met with considerable excitement among instructors of writing, it also has its critics. Critics argue that use of the word processor may have no effect, or even a detrimental one, on writing. The word processor does nothing to explicitly change writing performance; good and bad writers may write well and poorly regardless of the tool they use. Persons who have learned to write by hand will have to spend considerable energy to adjust to keyboarding, scrolling or paging texts on a screen, and learning new commands for simple tasks. Thus using the wordprocessor could actually distract learners from higher order thinking, especially when first learning the software. Furthermore, complementary functions such as spelling checks and text analyses could actually weaken a user's ability to spell and edit text because the computer has taken some responsibility for these functions.

## Method

Does research on word processing confirm any of these expectations? In 1986, Hawisher found 24 studies of word processing done since 1981. In the following year, Hawisher (1987) found an additional 16 studies. These 40 studies reported varied and conflicting results, but Hawisher drew some tentative conclusions. Final drafts of "word processed" documents contained fewer surface errors and were typically longer than handwritten documents. Students who used computers to write typically reported favorable attitudes toward the experience and many had improved attitudes toward writing itself. Many studies showed that poorer writers improved the quality of their writing after experience with word processing.

One of the difficulties that Hawisher faced in summarizing the studies was the variety in research methodology. Case studies, surveys, ethnographic studies, and informal exploratory studies were mixed with experimental studies in her review. The present project began as an attempt to conduct a meta-analysis of the comparative literature on word processing. A systematic effort was made to locate all studies that compared the effects of writing instruction with and without word processors. To locate relevant studies, computer-based searches of *Dissertation Abstracts International* and *Educational Resources Information Center (ERIC)* were conducted. Hawisher's reviews were an important source of leads for additional studies as were bibliographies of collected studies.

Twenty relatively sound studies of writing instruction were identified. Only about half of these had been previously reviewed by Hawisher (1987). Ideal studies, ones that would satisfy the requirements of meta-analysis and provide evidence of the effects of wordprocessing, proved hard to come by. All twenty studies compared the writing performance of an experimental and control group after treatment. However, there was not always sufficient information in the report to allow the calculation of effect sizes, nor was any particular dependent measure examined in all the studies. Eight of the studies had significant methodological flaws. Only five studies had identical posttest conditions for the experimental and control groups; most studies allowed the

experimental group to use the wordprocessor on the posttest. In four of the studies, students worked on only one assignment; in at least thirteen studies, the students worked on seven assignments or less. Under ideal conditions, students would work over relatively extended periods of time on a number of assignments, they would be tested under identical posttest conditions, and students would have basic keyboarding skills and sufficient numbers of easily accessible computers. These conditions were not met in most of the studies.

It became clear therefore that a true meta-analysis would not be possible for this area. To examine only the most methodologically sound studies with calculable effect sizes would severely constrain the sample in this review, and these numbers would be intolerably small when different dependent measures are examined separately. I decided therefore to calculate effect sizes where possible, but to resort to a narrative review procedure to summarize these studies.

## Results

Five types of outcomes were most commonly measured: number of revisions, composition length, attitude toward writing, basic writing skills (e.g., spelling, punctuation, and grammar), and overall quality of written documents.

In four studies, revisions in successive paper versions of compositions were tallied. This is the weakest of all the comparative measures. Though it addresses an important question, it fails to accurately measure the number of revisions in the wordprocessing group because many revisions take place before a printed copy is made. Not surprisingly, 3 of the 4 studies showed no effects or slightly negative results for the wordprocessing group. Only one study showed that wordprocessing increases the frequency of revision. It may bear noting that in 2 of the 4 studies, global and structural revisions were more common for the wordprocessing group than for the handwriting group. In the remaining 2 studies, students showed no difference in the number of global or surface revisions.

Six studies measured composition length. In four of the six studies, word processing students produced longer documents; in the two studies, hand-writing students produced longer documents. Four studies reported enough information to allow the calculation of effect size. The average effect of these four studies was 0.79 standard deviations which indicates a large increase in document length.

Four studies used questionnaires to determine students' attitudes toward writing. In three of the four cases, students who used the word processor expressed more favorable opinions of writing than did students who received the same instruction and composed the same assignments by hand. Effect sizes could be calculated for only three of the studies, two small (ES=0.13 and -0.23) and the other very large (ES=1.26). Suggestively, the measure of very positive attitudes came from above average high school students who volunteered to participate in a 12 week writing course at a local college.

It should be added that six studies reported informal comments gleaned from teachers and students who participated in the wordprocessing comparisons. Invariably, participating teachers and students said that wordprocessing had a beneficial effect on their writing. Typical comments showed that wordprocessing students needed less encouragement to revise and spent more time doing it, were more motivated and expended more time-on-task, and collaborated more with their peers. Dalton and Watson (1986) reported an interesting student comment that hints at a potentially important influence. Some students reported spending less time in planning the writing because revising was now so easy.

Seven studies compared the wordprocessing and handwriting groups on their basic writing skills, such as, spelling, punctuation, and grammar. Four of the studies had results favoring the

wordprocessing group, one study had negative results, and two studies showed no difference. Five effect sizes were calculable from this group, averaging 0.49 standard deviations.

Finally, in fifteen studies, judges gave wholistic ratings to compositions produced by wordprocessing and handwriting students. Thirteen studies found the wordprocessing students composed superior documents. One study showed no effect and one had a negative result. Ten of the studies delivered effect sizes averaging 0.40 standard deviations, a moderate improvement in composition quality. This improvement in composition quality had no apparent relation to the initial writing ability of students nor to other variables such as duration of program or grade level of students.

## Discussion

Many factors operated against the successful use of wordprocessing in these studies. Most implementations were relatively short and involved a small number of writing assignments. If students learn higher-order thinking from practice on wordprocessors, this should require extensive practice for its effects to be most noticeable. This is especially true when one realizes that most of the students in these studies had no keyboarding experience and were learning to use a particular wordprocessing software for the first time.

Perkins and Salomon (1986) have called this kind of indirect learning from repeated and varied practice with an instructional tool "low-road" learning. They suggest that such learning could be accelerated by "high-road" learning, mindful attention by learners to the underlying principles of the tool they are using and a readiness to thoughtfully generalize those principles to other situations. Teachers can explicitly assist this kind of high-road learning by pointing out these generalities and their applications. In only about half of these studies was additional instruction mentioned. In most cases, students were simply given assignments, conferenced with teachers about revisions, and eventually returned finished products.

Other obstacles to effective use of wordprocessors were evident in these studies. At least fourteen of twenty studies reported that the computers were located in a separate computer lab in the school. In many cases, this meant that students lost instructional time moving from their regular classes and setting up their work in the computer labs. For older students who did not own personal computers, this meant that they could only work on their papers in the lab, a limitation which did not affect the handwriting students. Of course, control students who personally owned wordprocessors could use them outside the study context. In several studies, there was a shortage of computers available for the wordprocessing group, and students had to engage in complex time-sharing procedures.

An uncontrolled but potentially very important feature of these studies is the design of the particular wordprocessors used. Bangert-Drowns and Kozma (1989) outlined some of the ways in which features of instructional tools can determine their instructional effectiveness. Perhaps chief among these features is the "user-friendliness" of the software. Is the command structure and operation of the program powerful, but easy to learn and control? Is the computer quickly responsive to commands of a student? Are inadvertent operational errors easy to identify and correct? These features were not examined or discussed in any of the comparative studies and only 11 studies reported the hardware or software used. It is clear from the 11 reporting studies that the hardware and software did not represent the "state-of-the-art," but were older, simpler, and possibly slower and more clumsy than more recent (and often more expensive) technology.

In spite of the various pitfalls which plagued these studies, wordprocessing still proved to be a beneficial addition to writing instruction. Counting the number of revisions detected on paper is a poor way to measure frequency of revision for students who are composing and revising electronic text. Perhaps more indicative of what student were doing with the wordprocessors was

their reported attitudes and comparisons of the lengths of their documents. Wordprocessing does appear to increase students' enjoyment of writing and stimulate them to compose longer documents. Perhaps the securest finding, which came from 13 of the 15 studies that examined this variable, was that wordprocessing students produced papers of better quality than handwriting students. In four of five studies where wordprocessing students had to write their final papers by hand, students who had used wordprocessing during instruction still produced papers of notably higher quality. (In the fifth study, there was no difference between groups.)

An unexpected finding from these studies is that wordprocessing students tended to also somewhat improve performance of their basic writing skills (e.g., spelling, punctuation, grammar, etc.). Hawisher (1987) similarly found that wordprocessing students produced documents with fewer surface errors. Four of the seven studies that looked at this variable showed positive results; two of these four studies used text analysis software to complement the use of the wordprocessor. It is possible that, because revision is considered easier and because some students could use text analyses, they were more inclined to attend to details of their papers.

On the basis of these findings, one can tentatively conclude that the wordprocessor operates as an instructional tool; that is, it instructs as it is being used. Specifically, the wordprocessor operates as an unsophisticated tool, representing text as a fluid form of communication and making revision of text easier than by hand. It does not, on the other hand, explicitly stimulate metacognitive activity.

None of the writing instruction in these studies explicitly accentuated the features of word processing. Borrowing Perkins and Solomon's (1986) term, all the wordprocessing studies in this review relied on "low-road" learning, acquiring higher-order thinking through repeated and varied practice. Perhaps even more positive effects could be achieved if instruction more explicitly encouraged "high-road" learning, causing students to reflect on generalized principles of writing that can be easily illustrated by the wordprocessor. These might include specific instruction regarding the fluidity of text and its close connection with thought and speech; the benefits to be derived from revision; the positive effects of brainstorming, organizing resources and notes, and other prewriting activities; the effects of simple structural changes on the meaning and impact of written communication; and the playful aspects of language mastery.

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